

Mean Areas and Heliographic Latitudes of Sun-spots in the year 1897, deduced from Photographs taken at the Royal Observatory, Greenwich; at Dehra Dûn (India); and in Mauritius.

(Communicated by the Astronomer Royal.)

The results here given are in continuation of those printed in the *Monthly Notices*, vol. lviii., p. 307, and are deduced from the measurements of solar photographs taken at the Royal Observatory, Greenwich; at Dehra Dûn, India; and at the Royal Alfred Observatory, Mauritius.

Table I. gives the mean daily areas of umbræ, whole spots, and faculæ for each synodic rotation of the Sun in 1897; and Table II. gives the same particulars for the entire year 1897 and the eight preceding years for the sake of comparison. The areas are given in two forms. First, projected areas—that is to say, as seen and measured on the photographs, these being expressed in millionths of the Sun's apparent disc; and next, areas as corrected for foreshortening, the areas in this case being expressed in millionths of the Sun's visible hemisphere.

Table III. exhibits for each rotation in 1897 the mean daily area of whole spots, the mean heliographic latitude of the spotted area, and the mean distance from the equator of all spots; and Table IV. gives the same information for the year as a whole, similar results from 1889 to 1896 being added, as in the case of Table II. Tables II. and IV. are thus in continuation of the similar tables for the years 1874 to 1888 on pp. 381 and 382 of vol. xlix. of the *Monthly Notices*.

The rotations in Table I. and Table III. are numbered in continuation of Carrington's series (*Observations of Solar Spots made at Redhill*, by R. C. Carrington, F.R.S.), No. 1 being the rotation commencing 1853, November 9. The assumed prime meridian is that which passed through the ascending node at mean noon on 1854, January 1, and the assumed period of the Sun's sidereal rotation is 25·38 days. The dates of the commencement of the rotations are given in Greenwich civil time, reckoning from mean midnight.

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TABLE I.

No. of Rotation.	Date of Commencement of each Rotation. ^d	No. of Days on which Photographs were taken.	Mean of Daily Areas.					
			Projected		Corrected for Foreshortening.			
			Umbrae.	Whole Spots.	Faculae.	Umbrae.	Whole Spots.	Faculae.
579	1897 Jan. 8.08	28	338	1919	1651	230	1335	1888
580	Feb. 4.43	26	208	1086	1446	154	817	1694
581	Mar. 3.77	27	100	544	1085	82	455	1293
582	Mar. 31.07	28	101	528	1188	74	391	1358
583	Apr. 27.33	27	86	542	805	57	364	972
584	May 24.55	27	69	335	670	54	268	798
585	June 20.76	27	64	385	776	47	289	898
586	July 17.96	27	137	886	948	98	647	1092
587	Aug. 14.18	27	109	806	881	100	565	972
588	Sept. 10.43	28	99	554	1140	74	423	1358
589	Oct. 7.71	27	3	28	677	3	24	820
590	Nov. 4.00	27	8	42	536	6	32	658
591	Dec. 1.32	28	172	1019	884	128	798	1091

TABLE II.

Year.	No. of Days on which Photographs were taken.	Mean of Daily Areas.					
		Projected		Corrected for Foreshortening.			
		Umbre.	Whole Spots.	Faculae.	Umbre.	Whole Spots.	Faculae.
1889	360	17.9	103	107	13.1	78.0	131
1890	361	21.3	133	273	15.5	99.4	304
1891	363	120	745	1322	86.2	569	1412
1892	362	255	1596	3230	186	1214	3270
1893	362	327	1983	2287	234	1464	2404
1894	364	317	1728	1666	231	1282	1877
1895	364	237	1330	2059	169	974	2278
1896	364	127	745	1243	90	543	1410
1897	364	122	695	977	88	514	1149

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TABLE III.

No. of Rotation.	Date of Commence- ment of each Rotation.	No. of Days on which Photographs were taken.	Spots North of the Equator. Mean of Daily Areas.	Spots South of the Equator. Mean of Daily Areas.	Mean Heliographic Latitude. Mean Heliographic Latitude of Entire Spotted Area.	Mean Distance from Equator of all Spots.
579	1897 Jan. 8.08	28	265	1070	7.67	0
580	Feb. 4.43	26	412	406	4.80	7.55
581	Mar. 3.77	27	260	195	5.57	6.84
582	Mar. 31.07	28	267	124	6.57	5.36
583	Apr. 27.33	27	86	278	12.09	4.44
584	May 24.55	27	4	263	10.83	10.03
585	June 20.76	27	6	283	7.00	10.66
586	July 17.96	27	222	425	6.21	7.03
587	Aug. 14.18	27	57	508	7.83	7.66
588	Sept. 10.43	28	191	232	8.41	8.49
589	Oct. 7.71	27	17	7	8.99	8.99
590	Nov. 4.00	27	20	12	9.85	9.54
591	Dec. 1.32	28	760	38	15.03	8.17
						10.51

TABLE IV.

Year.	No. of Days on which Photographs were taken.	Spots North of the Equator. Mean of Daily Areas.	Mean Heli- graphic Latitude.	Spots South of the Equator. Mean of Daily Areas.	Mean Heli- graphic Latitude.	Mean Heliographic Latitude of Entire Spotted Area.	Mean Distance from Equator of all Spots.
1889	360	5.0	+ 7.26	73.0	- 11.90	- 10.68	11.61
1890	361	53.1	+ 22.20	46.3	- 21.75	+ 1.73	21.99
1891	363	401	+ 20.49	169	- 19.91	+ 8.52	20.31
1892	362	607	+ 15.09	607	- 21.69	- 3.29	18.39
1893	360	517	+ 14.91	941	- 14.26	- 3.93	14.49
1894	364	543	+ 12.31	739	- 15.56	- 3.75	14.18
1895	364	565	+ 14.26	409	- 12.54	+ 3.01	13.54
1896	364	203	+ 13.60	340	- 14.77	- 4.15	14.33
1897	364	196	+ 8.32	318	- 7.73	- 1.62	7.96

The principal features of the record for 1897 are :

- (1) There has been a decrease in mean daily spotted area as compared with 1896, but only to a very small extent ; 5 per cent., as compared with the decrease of 44 per cent. of 1896 on the record for 1895. The rapidity of the decline which set in after 1893 seems therefore to have experienced a check.
- (2) The umbræ, like the spots, have shown scarcely any decrease ; in fact, only 2 per cent.
- (3) The decrease in the faculæ, on the other hand, has been considerable ; over 18 per cent.
- (4) The decline in the spots has been nearly in the same proportion in both hemispheres.
- (5) On the whole, therefore, the predominance in spot activity has rested, as in 1896, with the southern hemisphere.
- (6) But the chief characteristic of 1897 has been the great decline in the mean distance of the spots from the equator. This had remained practically unaltered during the four preceding years, at about 14° . The mean distance in 1897 is not quite 8° . This circumstance, taken by itself, would suggest, if the precedents of the minima of 1878 and 1889 are followed, that the minimum has nearly been reached. The continuance of so considerable a mean daily spotted area becomes, therefore, in this connection most remarkable.
- (7) The number of days without spots has increased considerably in 1897, being 32 as against 8 in 1896. The days without faculæ have remained the same—viz. 7.
- (8) The decline in latitude has been irregular in both hemispheres. In the northern hemisphere the decline was very great during the first half of the year, and was accompanied with a great decrease in spots. A secondary revival both in area and latitude ensued, followed in its turn by another decline, and another revival was setting in in the last month of the year. In the southern hemisphere there was a similar movement in latitude, but rather less pronounced and more irregular ; and the declines and revivals in latitude were not so strikingly synchronous with the declines and revivals in area.

Some remarks as to the Sun-spots of the present year may be added here to the above summary of results for 1897.

The last rotation in 1897—December 1–28—had been noteworthy for the appearance of a very fine group in the northern hemisphere, following upon a period of two complete synodic rotations, during which the solar activity had been very slight indeed, no single day showing a total spotted area of 150 (expressed, as usual, in millionths of the Sun's visible hemisphere),

whilst 14 days out of the 56 showed the Sun's disc wholly free from spots. During the appearance of this group—December 7–19—the mean daily spotted area of the Sun rose to 1390, practically equal to that of the years of maximum. After the disappearance of this group the spot activity remained fairly steady for the next two and a half months, a group which showed a considerable development running its course from February 8 to 20. This was the second appearance of a group which had formed near the centre of the disc on January 18, and which had shown some increase before it had reached the west limb on January 28. A series of minor magnetic disturbances continuously from January 15 to 21 accompanied the first appearance of this group. It made a third appearance, March 7–18, when it was accompanied by two fine groups, one to the north, the other south preceding. The latter, which was a very large group, crossed the central meridian on March 11, 12^h Greenwich civil time. These groups again raised the mean daily area for the period March 6–18 to 1390. After these groups had passed out of view at the west limb, no fresh outburst of importance occurred until August. A large magnetic disturbance and brilliant aurora occurred on March 15. The following table gives the mean daily areas for whole spots for the first nine rotations of 1898, so far as means are yet at hand for determining them :—

TABLE V.

No. of Rotation	Date of Commencement of each Rotation	No. of Days on which Photographs were taken	Mean of Daily Areas. Whole Spots
593	1897 December 28 ⁶⁴	26	435
594	1898 January 24 ⁹⁸	28	526
595	February 21 ³²	25	787
596	March 20 ⁶⁴	27	157
597	April 16 ⁹²	27	229
598	May 14 ¹⁶	28	114
599	June 10 ³⁶	24	47
600	July 7 ⁵⁶	18	210
601	August 3 ⁷⁷	19	295
Mean for the period 1897 December 28–August 31			222 315

Up to the end of August, therefore, in spite of the activity in March, and the two less important revivals in February and at the beginning of August, the mean daily area had fallen markedly below that for 1897. But quite a new period set in with the appearance of a very fine group on the east limb on September 3. Table VI. exhibits the principal facts respecting this group during its first apparition, September 3–15 :—

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TABLE VI.

Date 1898	d	Area of Whole Spots			Hel. Co-ordinates of Chief Spot Longitude Latitude	Length of Group
		Entire Disc	Entire Group	Chief Spot		
September	3·438	1144	1014	956	240°9'—12°6'	5
	4·476	1218	1092	1033	240°6'—12°6'	
	5·649	1149	1041	1004	240°6'—12°3'	
	6·428	1228	1123	1006	240°6'—12°1'	12
	7·648	1444	1369	1120	240°2'—12°1'	14
	8·480	1782	1782	1148	241°1'—12°6'	16
	9·624	2021	2021	1169	241°3'—12°1'	17
	10·444	2243	2235	1150	240°8'—12°6'	18
	11·435	2201	2201	1131	241°3'—12°8'	18
	12·477	1830	1830	1090	241°6'—13°1'	17
	13·628	1912	1912	1123	241°6'—12°8'	18
	14·433	2089	1968	1615	240°7'—12°3'	16
	15·441	874	597	271	240°6'—13°6'	

The mean daily area for this period, September 3–15, was therefore 1626, and was almost entirely due to the one group, which of itself gave a mean daily area of 1553.

The group crossed the central meridian on September 9, and attained its greatest development on September 10. At first the group had consisted almost entirely of the chief spot, but by September 7 a considerable stream of smaller spots had formed behind it. These increased in area on the succeeding days up to September 10, the chief spot varying very little in size. After September 10 the spots in the middle of the following stream began to disappear, and the group was interrupted by a broad gap. The development of the smaller following spots caused a rapid increase in the length of the group from September 3 to 10, after which there was a slight decline. The maximum length of the group was 135,000 miles on September 10. A great magnetic disturbance, with a brilliant aurora, occurred on September 9, when this group crossed the central meridian.

The group returned to the east limb on September 29, but had considerably diminished in size; it crossed the central meridian on October 6, and reached the west limb on October 12. It appeared at the east limb for the third time on October 27, a single spot of area about 70.

Advantage was taken of the first appearance of so fine a group to make some experiments with the 26-inch Thompson photographic equatorial. A negative enlarger was employed in the telescope, giving an image of the Sun on a scale of 29 inches to the solar diameter. After exposing a number of plates in order to find the focus, two were secured, one on September 11,

the other on September 14, that are nearly in the correct focus, and which show a considerable amount of fine detail. Some difficulty was experienced with the Thornton-Pickard exposing shutter, which has not yet been entirely overcome.

Since the appearance of the great group, September 3-15, several other groups of smaller, but still very considerable dimensions, have been seen, so that the present revival of activity has been by no means confined to a single group. The two principal passed the central meridian on October 28 and November 5 respectively.

The figures given for 1898 are approximate only.

Observations of Planet (433) (1898 D Q) made at the Royal Observatory, Greenwich, with the 30-inch Reflector of the Thompson Equatorial.

(Communicated by the Astronomer Royal.)

Photographs of Planet D Q were obtained with the 30-inch reflector of the Thompson Equatorial by Mr. Davidson on 1898 September 20, September 21, September 23, October 3 and November 3. An attempt was made on November 1 to obtain a photograph with the Astrographic Equatorial, but nothing was shown with an exposure of 12^m, presumably because the planet's motion was so rapid (being about 50'' an hour).

The exposures given were 20^m on September 20, 20^m on September 21, 15^m on September 23, two exposures of 10^m and 5^m on October 3, and an exposure of 20^m on November 3.

On account of the faintness of the planet (whose photographic magnitude is given by Professor Pickering as 12^m.7 about the middle of September) the reflector was used for these photographs as having more light grasping power than the 26-inch refractor, although the distortion of the field is greater.

In all the photographs the planet was photographed near the centre of the plate. Its position on the plate and those of from 14 to 16 comparison stars were measured in the duplex micrometer. As no *réseau* had been printed on the plates excepting on the plate of November 3, a plate on which a *réseau* had been printed was placed under the right hand microscope of the micrometer, and was used instead of a *réseau* on the plate.

The Right Ascensions and Declinations of the reference stars were taken from the Ottakring Zone Observations for the *Astronomische Gesellschaft Catalogue*, except in the case of B.D. - 5° 5335 and B.D. - 5° 5349, for which the positions were derived from the Karlsruhe Observations and the Radcliffe Catalogue. For B.D. - 6° 5558, - 6° 5567 and - 6° 5568, the means of the Right Ascensions and Declinations given in the Ottakring Zones, the Radcliffe Catalogue for 1890, and the Karlsruhe Observations were taken.